

## TITLE OF THE INVENTION

### PAPER DETECTING APPARATUS FOR DUPLEX IMAGE FORMING MACHINE

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims the benefit of Korean Application No. 2002-57014, filed September 18, 2002, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

**[0002]** The present invention relates to a paper detecting apparatus for an image forming machine, and more particularly, to a paper detecting apparatus capable of detecting whether duplex paper is fed and the presence of paper stacked on a paper feed cassette in an image forming machine having a duplex image forming function.

### 2. Description of the Related Art

**[0003]** An image forming machine includes a printer, a copier and a multifunction machine supplying paper to a paper feed cassette and having a duplex printing function.

**[0004]** Generally, an image forming machine feeding paper using a paper feed cassette and having a duplex printing function that forms images on two sides of the supplied paper comprises a sensor that detects whether paper is stacked in the paper feed cassette, and another sensor that detects paper being conveyed in a duplex printing operation.

**[0005]** FIG. 1 shows an embodiment of an image forming machine having a conventional paper detecting apparatus that detects whether paper passes a duplex printing paper path and whether paper is stacked in the paper feed cassette.

**[0006]** Referring to FIG. 1, the conventional paper detecting apparatus comprises a first detector 10 that detects the presence of paper in the paper feed cassette 30, and a second detector 20 that detects the paper passing the duplex printing paper path 40.

**[0007]** The first detector 10 comprises a first actuator 13, a first sensor 15, and an operating slot 34.

**[0008]** The first actuator 13 comprises a paper touching portion 11 being in contact with the stacked paper, and a sensor operator 12 that operates the first sensor 15, and is formed to have the sensor operator 12 located outside the sensing area of the first sensor 15 when paper is stacked in the paper feed cassette 30. The first actuator 13 is pivotably hinged on a first hinge shaft 14 with one end disposed above the duplex printing paper path 40, and formed to have the paper touching portion 11 weighing more than the sensor operator 12. Accordingly, the first actuator 13 always has a tendency to pivot downward around the first hinge shaft 14. The duplex paper printing path 40 has a slot 41 of a predetermined size formed to allow the paper touching portion 11 of the first actuator 13 to operate.

**[0009]** The first sensor 15 is disposed above the duplex paper printing path 40 and senses the movement of the sensor operator 12 when there is no paper on the paper feed cassette 30. The first sensor 15 uses a photo sensor.

**[0010]** The operating slot 34 is formed on a paper pressing plate 32 of the paper feed cassette 30. When no paper is stacked in the paper feed cassette 30, the first actuator 13 pivots downward and the paper touching portion 11 is inserted into the operating slot 34. The operating slot 34 is formed to have the paper touching portion 11 stopped at the rear end of the operating slot 34 thereby stopping the first actuator 13 when the sensor operator 12 of the first actuator 13 is in the sensing area.

**[0011]** The second detector 20 includes a second actuator 23, a second sensor 25, and a swing slot 42.

**[0012]** The second actuator 23 comprises a paper interfering portion 21 interfering with paper being fed to the duplex printing paper path 40, and a sensor operating portion 22 that operates the second sensor 25. The second actuator 23 is rotatably assembled around the second hinge shaft 24 disposed above the duplex printing paper path 40. The paper interfering portion 21 is formed to weigh more than the sensor operating portion 22, thereby always being located below the sensor operating portion 22. Therefore, when paper is not fed to the duplex printing paper path 40, the sensor operating portion 22 is located inside the sensing area of the second sensor 25.

**[0013]** The second sensor 25 is disposed above the duplex printing paper path 40 and senses the operation of the sensor operating portion 22 of the second actuator 23. The second sensor 25 generally uses a photo sensor.

**[0014]** The swing slot 42 is formed on the duplex printing paper path 40 and has a size allowing the paper interfering portion 21 to move freely.

**[0015]** The conventional paper detecting apparatus having the above described structure operates as described hereinafter.

**[0016]** Firstly, to describe the operation of the first detector 10, when paper is stacked in the paper feed cassette 30, the paper touching portion 11 is located above the paper as shown in FIG. 1 and the sensor operator 12 is located outside the sensing area of the first sensor 15. (shown in broken lines in FIG. 1) Although paper supply is continued, the paper touching portion 11 maintains its location by the paper pressing plate 32 of the paper feed cassette 30. When the rear end of the last paper stacked in the paper feed cassette 30 passes the operating slot 34, the paper touching portion 11 is inserted into the operating slot 34, and the sensor operator 12 is located inside the sensing area of the first sensor 15 as the first actuator 13 pivots. The first sensor 15 then generates signals. When signals are generated from the first sensor 15, the image forming machine senses that no paper is stacked in the paper feed cassette 30 and indicates the absence of the paper in the paper feed cassette 30.

**[0017]** To describe the operation of the second detector 20, when paper that has received first side imaging while passing an image forming apparatus of an image forming machine, enters the duplex printing paper path 40, the front end of the paper is interfered with by the paper interfering portion 21 of the second actuator 23. As the paper continues to move, the paper interfering portion 21 pivots upward, and the sensor operating portion 22 escapes from the sensing area of the second sensor 25. Then the second sensor 25 generates signals. When the signals are generated from the second sensor 25, the image forming machine senses that the paper is moving along the duplex printing paper path 40 and performs necessary operations.

**[0018]** When the paper is continually fed, the paper touching portion 11 of the first actuator 13 is pushed upward thereby operating the first sensor 15. However, when the image forming machine receives signals from the second sensor 25, the signals from the first sensor 15 are

ignored during a predetermined period until the paper escapes from the area in which it is interfered with the first detector 10. Accordingly, the paper being fed along the duplex printing paper path 40 can be detected regardless of the operation of the first sensor 15.

**[0019]** By using the conventional paper detecting apparatus described above, the image forming machine can detect the presence of the paper in the paper feed cassette and paper being fed along the duplex printing paper.

**[0020]** However, the conventional paper detecting apparatus uses two identical sensors each requiring a separate actuator, and a slot on the duplex printing paper path that allows the actuators to operate, thereby increasing material costs. In addition, since such a paper detecting apparatus employs a lot of parts, the number of assembling processes increases and therefore productivity declines. Moreover, since two sensors are used, it is highly likely to have malfunction of the sensors and accordingly, the product can be assessed as being unreliable.

#### SUMMARY OF THE INVENTION

**[0021]** An aspect of the invention is to solve at least the above and/or other problems and disadvantages and to provide at least the advantages described hereinafter.

**[0022]** Accordingly, aspect of the present invention is to solve the foregoing and/or other problems by providing a paper detecting apparatus of an image forming machine capable of sensing the presence of the paper in the paper feed cassette and paper being fed along a duplex printing paper path by using a single sensor thereby reducing material costs and improving productivity and reliability.

**[0023]** Additional and/or other aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

**[0024]** The foregoing and/or other aspects and advantages are realized by providing a paper detecting apparatus of an image forming machine having a duplex printing function comprising an actuator, pivotably disposed above a paper feed cassette in which paper is stacked and below a duplex printing paper path along which the paper moves during printing of a side, the actuator being moved by the paper, and a paper sensor, disposed next to the actuator that senses movement of the actuator and generates a signal, wherein the actuator pivots in a

predetermined angle when no paper is stacked in the paper feed cassette or paper is being fed along the duplex printing paper path, and the paper sensor generates the signal upon sensing the pivoting actuator.

**[0025]** The actuator comprises a hinge shaft, a center pivotably assembled around the hinge shaft, a first lever extended from the center that operates the paper sensor when no paper is stacked in the paper feed cassette, a second lever extended from the center having a predetermined angle from the first lever that operates the paper sensor when paper is fed along the duplex printing paper path; and a third lever extended from the center toward the opposite direction of the first and second levers and weighing more than the combined weight of the first and second lever, wherein the first lever and the second lever have a tendency to rotate in one direction by the third lever.

**[0026]** The predetermined angle is determined so the second lever does not operate the paper sensor when the third lever is in contact with paper on the paper feed cassette. The paper feed cassette has a slot that allows the third lever to pass through.

**[0027]** The paper detecting apparatus of an image forming machine according to the present invention further comprises a stopper limiting pivoting space of the actuator.

**[0028]** The paper detecting apparatus of an image forming machine according to the present invention comprises a first slot formed on a duplex printing paper path a hinge shaft disposed under the duplex printing paper path, a center pivotably assembled on the hinge shaft, a second lever extended from the center toward inside of the first slot and interfered by paper when the paper moves along the duplex printing paper path, a first lever extended from the center having a predetermined angle from the second lever and located outside sensing area of the paper sensor when paper is stacked in a paper feed cassette, a third lever extended from the center toward the opposite direction of the first and second levers and heavier than the combined weight of the first and second levers, a paper sensor disposed between the first and second levers for sensing movement of the first and second lever, and a second slot formed on the paper feed cassette for allowing the third lever to pass through, wherein the third lever pivots downward and the first lever is located inside sensing area of the paper sensor when no paper is stacked in the paper feed cassette, and the second lever pivots and is located inside sensing

area of the paper sensor, and then escapes from sensing area of the paper sensor by the third lever when paper moves along the duplex printing paper path.

**[0029]** The second lever is interfered with by a rear end of the first slot when the first lever is located inside sensing area of the paper sensor and not located inside sensing area of the paper sensor when the third lever is in contact with paper stacked in the paper feed cassette.

**[0030]** The paper sensor is a photo sensor.

**[0031]** As described above, the paper detecting apparatus of an image forming machine according to the present invention is able to detect whether paper is stacked in the paper feed cassette and the paper is conveyed to the duplex printing paper path using a single sensor. Therefore, according to the present invention, a paper detecting apparatus of an image forming machine with material costs reduced and productivity and reliability improved.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0032]** These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments taken in conjunction with the accompanying drawings in which:

FIG. 1 is a view showing an image forming machine having a conventional paper detecting apparatus;

FIG. 2 is a view showing an image forming machine having a paper detecting apparatus according to an embodiment of the present invention;

FIG. 3 is a view showing an actuator of the paper detecting apparatus of FIG. 2 when paper is stacked in a paper feed cassette;

FIG. 4 is a view showing the actuator of FIG. 3 when no paper is stacked in the paper feed cassette;

FIG. 5 is a view showing the actuator of FIG. 3 rotated by paper being fed along a duplex printing paper path;

FIG. 6 is a view showing the actuator rotating in the reverse direction after the operation of FIG. 5;

FIG. 7 is a flow chart showing a method for an image forming machine to detect the absence of paper in a paper feed cassette and paper being fed along the duplex printing paper path by the operation of the paper sensor; and

FIG. 8 is a flow chart showing another method for an image forming machine to detect the absence of paper in a paper feed cassette and paper being fed along the duplex printing paper path by the operation of the paper sensor.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0033]** Reference will now be made in detail to a paper detecting apparatus of an image forming machine according to a preferred embodiment of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

**[0034]** Referring to FIG. 2, the paper detecting apparatus 100 of the image forming machine 200 according to the present invention comprises an actuator 110, a paper sensor 120, a first slot 142, and a second slot 134.

**[0035]** The actuator 110 is pivotably disposed around a hinge shaft 105 disposed below a duplex printing paper path 140. The actuator 110 comprises a first lever 111, a second lever 112, and a third lever 113 extended from the center 115 and therefore has a shape similar to the letter Y.

**[0036]** The center 115 is rotatably hinged on the hinge shaft 105 disposed below the duplex printing paper path 140.

**[0037]** The first lever 111 located inside the sensing area of the paper sensor 120 when no paper is stacked in a paper feed cassette 130, and outside the sensing area of the paper sensor 120 when paper is stacked in the paper feed cassette 130.

**[0038]** The second lever 112 extends from the center 115 having a predetermined angle from the first lever 111, and has a free end located in the first slot 142 formed on the duplex printing paper path 140 and interfering with paper being fed along the duplex printing paper path 140. The second lever 112 is to be stopped at the rear end 142a of the first slot 142 when no paper is stacked in the paper feed cassette 130 and accordingly the actuator 110 pivots. In addition, the

second lever 112 is to be outside the sensing area of the paper sensor 120 when the third lever 113 is in contact with the upper surface of the paper stacked in the paper feed cassette 130.

**[0039]** The third lever 113 extends from the center 115 away from the first lever 111 and the second lever 112. The third lever 113 maintains contact with the upper surface of the paper stacked in the paper feed cassette 130 when the first lever 11 is in the sensing area of the paper sensor 120. The third lever 113 weighs more than the combined weight of the first lever 111 and the second lever 112 and, accordingly, the third lever 113 has a tendency to pivot downward. In addition, the third lever 113 pivots upward by the impact occurring when the paper being fed along the duplex printing paper path 140 hits the second lever 112. Therefore, the third lever 113 is heavier than the combined weight of the first lever 111 and the second lever 112 and at the same time light enough so as to be moved by the impact brought by the paper moving along the duplex printing paper path 140. To satisfy such conditions, the inside of the third lever 113 is cut out.

**[0040]** It would be appreciated by those skilled in the art that the phenomenon of the third lever causing a tendency for the actuator to pivot in a counter-clockwise direction and be movable when paper moving along the duplex printing paper path 140 impacts the second lever can be achieved in ways beside making the third lever heavier than the combined weights of the first lever 111 and the second lever 112.

**[0041]** The paper sensor 120 is disposed next to the first lever 111 and the second lever 112 of the actuator 110 below the duplex printing paper path 140. When paper is stacked in the paper feed cassette 130, the paper sensor 120 is located in the space between the first lever 111 and the second lever 112. The paper sensor 120 can use any device such as a limited switch as long as it can sense the operation of the first lever 111 and the second lever 112 but preferably, it uses a photo sensor.

**[0042]** The first slot 142 is formed on the duplex printing paper path 140 for the second lever 112 to freely pivot. The length of the first slot 142 is formed so a rear end 142a of the first slot 142 acts as a stopper limiting the pivoting space of the actuator 110 when no paper is stacked in the paper feed cassette 130. Therefore, the length of the first slot 142 is formed so the second lever 112 is stopped by the rear end 142a of the first slot 142 and the first lever 111 is located



inside the sensing area of the paper sensor 120 when the third lever 113 is inserted into the second slot 134.

**[0043]** The second slot 134 is formed on the paper pressing plate 132 of the paper feed cassette 130 for the third lever 113 of the actuator 110 to freely pivot. The length of the second slot 134 may extend along the entire length of the paper pressing plate. However, the front end 134a of the second slot 134 acts as a stopper when the rear end 142a of the first slot 142 does not act as a stopper. That is, the length of the second slot 134 is determined for the actuator 110 to stop pivoting with the first lever 111 located inside the sensing area of the paper sensor 120 when the actuator 110 pivots with the third lever 113 being inserted into the second slot 134.

**[0044]** Hereinafter, the operation of the paper detecting apparatus 100 of an image forming apparatus 200 according to the present invention having the above-described structure will be described in detail referring to the accompanying FIGS. 2 through 6.

**[0045]** Beginning with the operation of detecting the presence of paper in the paper feed cassette 130, when paper 101 is stacked in the paper feed cassette 130, the actuator 110 pivots to appear as in FIG. 3. Even while the paper 101 is continually being fed, the actuator 110 maintains its position as the paper pressing plate 132 keeps the paper 101 in a predetermined height. When the last paper is fed from the paper feed cassette 130, the third lever 113 of the actuator 110 pivots downward, thereby being inserted into the second slot 134 formed on the paper pressing plate 132. The actuator 110 stops pivoting as the second lever 112 is stopped by the rear end 142a of the first slot 142 and, accordingly, the first lever 111 integrally formed with the third lever 113 pivots, thereby being located inside the sensing area of the paper sensor 120. (see FIG. 4) When the first lever 111 is located inside the sensing area of the paper sensor 120, the paper sensor 120 generates signals. The image forming machine receives signals from the paper sensor 120, and then indicates that no paper remains in the paper feed cassette 130.

**[0046]** When paper is stacked in the paper feed cassette 130, the third lever 113 pivots clockwise and the first lever 111 moves outside the sensing area of the paper sensor 120 as shown in FIG. 3.

**[0047]** The operation of detecting the paper being fed along the duplex printing paper path during the duplex printing will be described in the following .

**[0048]** The paper 102 with the front side printed with an image passing an image forming unit (not shown) enters the duplex printing paper path 140. The paper 102 with the front side printed with an image entering the duplex printing paper path 140 continues to move forward, hitting the second lever 112, and thereby allowing the second lever 112 to pivot clock-wise. When the paper 102 hits the second lever 112, the actuator 110 rotates clockwise by the impact, and the second lever 112 is located inside the sensing area of the paper sensor 120 as shown in FIG. 5. After the impact created by the paper 102 dissipates, the actuator 110 rotates counter-clockwise due to the weight of the third lever 113. When the actuator 110 rotates counter-clockwise, the second lever 112 escapes from the sensing area of the paper sensor 120, thereby pressing the paper 102 passing the first slot 142 upward. (see FIG. 6) That is, when paper 102 is fed along the duplex printing paper path 140, the second lever 112 is temporarily located inside the sensing area of the paper sensor 120 by the impact between the paper 102 and the second lever 112 and escapes from the sensing area of the paper sensor 120 by the weight of the third lever 113. Accordingly, the paper sensor 120 generates signals for a short period during which the second lever 112 is inside the sensing area. When the rear end of the paper 102 completely passes the first slot 142, the second lever 112 is inserted into the first slot 142 and the actuator 110 returns to the position shown in FIG. 3.

**[0049]** As described above, the period signals generated when no paper is stacked in the paper feed cassette and the period signals generated by the paper being fed along the duplex printing paper path are different. Therefore, the image forming machine can identify whether the signals are due to a detected absence of paper in the paper feed cassette or a detected paper being fed along the duplex printing paper path in accordance to the length of the signals.

**[0050]** As shown in FIG. 7, after receiving an "on" signal from the paper sensor, ( 150) the image forming machine measures the length of the signal and compares the length of the received signal with the standard length. ( 160) If the length of the signal received from the paper sensor is shorter than the standard length, it is judged that the paper is being fed along the duplex printing paper path. ( 170) On the other hand, if the length of the signal received from the paper sensor is longer than the standard length, it is judged that there is no paper in the paper feed cassette. ( 180) The standard length here is determined by measuring how long

it takes for the second lever to escape from the sensing area of the paper sensor by the weight of the third lever after the second lever of the actuator enters inside the sensing area of the paper sensor by the paper fed into the duplex printing paper path.

**[0051]** Another method by which an image forming machine detects the paper being fed along the duplex printing paper path by the signal of the paper sensor is now described.

**[0052]** Referring to FIG. 8, the image forming machine receives a signal from the paper sensor ( 190) and then a controller (not shown) in the image forming machine judges if the image forming machine is in a duplex printing mode. ( 200) If the image forming machine is in the duplex printing mode, it judges that paper is being fed to the duplex printing paper path. ( 210) However, if the image forming machine is not in the duplex printing mode, the signal received by the controller will indicate that there is no paper in the paper feed cassette, and the controller judges that there is no paper in the paper feed cassette. ( 220) That is, if the image forming machine receives a signal from the paper sensor in the duplex printing mode, it judges that paper is being fed to the duplex printing paper path.

**[0053]** As described above, the paper detecting apparatus of an image forming machine according to the present invention can judge the presence of paper in the paper feed cassette and paper being fed to the duplex printing paper path by a single sensor. Therefore, material costs and the number of assembling processes can be reduced. Moreover, the product reliability can be improved as the malfunction of sensors is decreased by reducing the number of sensors.

**[0054]** Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.